



Metropolitan Area ITS Implementation Plan

Benefit/Cost Analysis

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1. INTRODUCTION

Several Intelligent Transportation Systems (ITS) projects have been undertaken in the Albuquerque Metropolitan Area that provide a solid foundation for the regions' ITS program. These include a new centrally-controlled traffic signal system being installed in the Cities of Albuquerque and Rio Rancho, the Advanced Metropolitan Traffic Management System (AMTMS) being designed on Interstate 40 and Interstate 25, and deployment of smart corridors in Bernalillo County.

In an effort to provide coordinated solutions to addressing transportation issues in the region, the Mid-Region Council of Governments (MRCOG) in cooperation with local, regional, state, and federal partners, has undertaken the "Metropolitan Area ITS Implementation Plan" study. The purpose of the study is to develop a comprehensive, phased plan for future ITS deployment so that agencies can coordinate ITS projects to maximize technology investments, and to mainstream ITS projects with other construction projects, resulting in overall cost savings.

The plan is intended to help technical managers and policy makers to understand the benefits of specific ITS projects in both technical and political terms in advance of requests for funding. This will help them by providing a basis for evaluating ITS projects in the context of competing interests. While the benefits of ITS have been well advertised from other regions, ITS implementation in this region is dependent on generating reliable estimates of the benefits that can be achieved through the implementation of ITS in the Albuquerque metropolitan area.

The *ITS Deployment and Analysis Document* presented an analysis of roadway segments, identification of elements that could be considered for deployment on arterials and freeways in the Albuquerque Metropolitan area, and an incremental, phased plan for the build-out of the Region's Intelligent Transportation System. The purpose of this document is to present a preliminary opinion of costs and anticipated benefits of the ITS projects that were recommended for deployment in the *ITS Deployment and Analysis Document*.

The key tool utilized in the benefit/cost analysis was the Intelligent Transportation System Deployment Analysis (IDAS) program. The IDAS model is a systematic tool used to compare ITS alternatives through an estimation of benefits such as improved travel time and reduced vehicle emissions, while accounting for the costs of ITS deployment.

A clear view of the anticipated benefits and costs of ITS deployment will help decision-makers prioritize ITS deployment projects, with the objective of improving the reliability and efficiency of the transportation system in the Albuquerque metropolitan area.

2. ANALYSIS METHODOLOGY

The IDAS Model was utilized to perform the benefit/cost analysis for the corridor-based projects. The following summarizes our analysis methodology:

1. As a part of the previous task, ITS elements were recommended for deployment on Albuquerque metropolitan area roadways. ITS deployments were separated into 16 corridor-based packages to be deployed in two phases.
2. Some of the 16 corridor packages were combined to form deployable “ITS Options,” for input into the model to better represent construction project packaging (aggregation was based primarily on preliminary project construction cost estimates) and to create a realistic basis for building the model scenarios and prioritizing projects.
3. A two-day hands-on workshop, involving the consultant team and MRCOG staff resolved IDAS model input methodology and began the process of performing the input of the “ITS Options” into the IDAS model.
4. MRCOG separately ran the IDAS model for each of the “ITS Options” in both phases of the proposed implementation plan in order to estimate benefits on a project-by-project basis.
5. MRCOG ran the model with all of the “ITS Options” deployed for each implementation phase to analyze the net effect of full deployment in the region.
6. The Consultant team utilized the model base provided by MRCOG, including the ITS projects, to iterate through several additional model runs in order to fine tune the inputs, cost estimates and model settings for benefit estimation.
7. The Consultant team analyzed the model outputs to assist in prioritizing projects and project components.
8. A benefit/cost analysis compared the full deployment of each phase against the sum of individual deployments, in order to estimate the aggregate benefits accrued by implementation of the whole system.

The results of the analysis and conclusions are described in the following sections.

3. SYSTEMS AND FIELD ELEMENTS RECOMMENDED FOR DEPLOYMENT

Section 4.1 and Section 4.2 of the *ITS Deployment and Analysis Document* recommended region-wide systems (such as traveler information) and specific ITS project corridors for deployment in the Albuquerque metropolitan area. This section reviews the recommendations made in sections 4.1 and 4.2.

3.1 Region-wide Systems

Section 4.1 of the *ITS Deployment and Analysis Document* recommended system-wide deployment of the following systems:

Traveler Information – Continued deployment of the infrastructure required to support a comprehensive traveler information system is recommended. Infrastructure elements may include arterial and freeway vehicle detection devices to detect real-time traffic conditions, as well as information from transit, parking, incident, and weather services. The information should be broadly disseminated through multiple media such as radio, internet, television, and telephone (511) services.

Portable Traveler Information Dissemination Devices – The region should continue to use portable traveler information dissemination devices (portable changeable or dynamic message signs) for use during construction and special events.

Communications Infrastructure – Center-to-field and field-to-field (interconnect) communications should be deployed as necessary to support the ITS project applications intended for deployment within the region. Additionally, the region should continue to deploy center-to-center communications between transit management, incident management, emergency management, and traffic management agencies to improve regional coordination and to support the collection of traveler information. The communication master plan previously prepared for the City of Albuquerque should be updated to reflect the ITS projects being recommended by this project and expanded to cover the transportation system communication needs of the greater metropolitan area.

Region-wide Signal Synchronization – The region should continue to deploy the hardware and software necessary to enable signal coordination and synchronization across jurisdictional boundaries. The Cities of Albuquerque and Rio Rancho are upgrading their signal systems.

Joint Operation Center – Preliminary planning should begin for the implementation of a joint-use facility that will provide the foundation for an integrated deployment of ITS throughout the region. The facility would provide for the needs of transportation and public safety/emergency management personnel. The joint-use facility would serve the regions' needs for transportation management system operations, data collection and processing, and integrated incident and emergency management. Primary partners would include the City of Albuquerque, Bernalillo County, and the New Mexico Department of Transportation (NMDOT), with communication links provided for coordination with other agencies, such as the City of Rio Rancho, the Emergency Operation Center (EOC), and maintenance departments of various agencies. The NMDOT AMTMS TMC, currently in the planning phases, is a potential facility whose scope could be expanded to include this joint functionality.

3.2 Corridor-specific Field Elements and Development of “ITS Options”

Section 4.2 of the *ITS Deployment and Analysis Document* outlined the roadways recommended for corridor-based ITS deployment over the next ten years. That report recommends that ITS deployment on the roadways be done in two phases for cost-effective deployment. The objective of early phase deployments is to establish a region-wide infrastructure such as a communications backbone and a network of surveillance and detection elements at critical points in the transportation system. The second phase consists of the build-out of early-phase deployments. For example, a Phase 1 deployment may consist of widely-spaced detectors and surveillance cameras at several critical locations on a particular corridor. Additional cameras and detectors would then supplement the initial deployment in Phase 2 on that same corridor.

To facilitate this phased approach to ITS deployment, the recommended roadways and ITS elements were separated into 16 corridor-based packages. Corridor projects were subsequently grouped into “ITS Options,” for the purpose of IDAS model input for this benefit/cost analysis, with each “ITS Option” consisting of one or more corridors. Corridors with small ITS deployments were aggregated to form more realistic construction packages.

Table 3-1 and **3-2** show a summary of the “ITS Options” for Stage 1 and Stage 2 deployments respectively. They are not listed in any order or priority. Each option description lists the corridors included in the option as well as a summary of the ITS elements recommended on the corridor. While specific quantities of elements were estimated, they are intended for benefit/cost analysis only. This is not intended to be a comprehensive conceptual design. Specific quantities of elements were determined for the purpose of developing program-level cost estimates and for the benefit/cost analysis.

Table 3-1: Summary of Deployment Elements for Stage 1 “ITS Options”

ITS Option Packaging in IDAS	Corridors	ITS Elements Deployed in Option
ITS OPTION 1	Coors	7 CCTV Cameras 1 Pavement Sensor 15 Trailblazer Signs (Arterial-based changeable message signs) 14.5 Miles Fiber Optic Cable 6 Remote Traffic Monitoring Stations
	Alameda/528	1 CCTV Camera 4 Remote Traffic Monitoring Stations 15 Traffic Signal Controller Upgrades 1 Pavement Sensor Traffic Signal Coordination
ITS OPTION 2	2nd Street	4 CCTV Cameras 6 Remote Traffic Monitoring Stations 17 Traffic Signal Controller Upgrades 8 Miles Fiber Optic Cable Traffic Signal Coordination
ITS OPTION 3	Gibson	4 CCTV Cameras
	Central	2 CCTV Cameras 1 Pavement Sensor
	Louisiana	1 CCTV Camera
	Lomas	2 CCTV Cameras
ITS OPTION 4	Montano	1 CCTV Camera 5 Remote Traffic Monitoring Stations 1 Pavement Sensor
ITS OPTION 5	Paseo Del Norte	9.5 Miles Fiber Optic Cable 3 Remote Traffic Monitoring Stations 1 Pavement Sensor
ITS OPTION 6	Bridge	1 Pavement Sensor
	Rio Bravo	1 Pavement Sensor
ITS OPTION 7	US 550	1 CCTV Camera 1 Road Weather Information System
ITS OPTION 8	Tramway	1 CCTV Camera 1 Road Weather Information Systems 5 Pavement Sensor 7.5 Miles Fiber Optic Cable 16 Traffic Signal Controllers Upgrade
ITS OPTION 9	Urban Interstates	CCTV Cameras Dynamic Message Signs 75 Remote Traffic Monitoring Stations 2 Pavement Sensors 33 Traffic Signal Controllers/Cabinets Upgrade (Frontage Roads) Traffic Signal Coordination (Frontage Roads)
ITS OPTION 10	Extended Area Interstates	2 CCTV Cameras 2 Road Weather Information Systems 1 Remote Traffic Monitoring Stations

Table 3-2: Summary of Deployment Elements for Stage 2 “ITS Options”

ITS Option Packaging in IDAS	Corridors	ITS Elements deployed on Corridors
ITS OPTION 1	Coors	27 Traffic Signal Controller Upgrades Traffic Signal Coordination 3 Arterial DMS 3 Trailblazer Signs
ITS OPTION 2	Alameda/528	3 CCTV Cameras 2 Remote Traffic Monitoring Stations 15 Traffic Signal Controller Upgrades Traffic Signal Coordination 1 Arterial DMS
ITS OPTION 3	Gibson	3 Remote Traffic Monitoring Stations 10 Traffic Signal Controller Upgrades Traffic Signal Coordination 2 Arterial DMS
ITS OPTION 4	Central	5 CCTV 10 Remote Traffic Monitoring Stations 50 Traffic Signal Controller Upgrade Traffic Signal Coordination
ITS OPTION 5	Lomas	2 CCTV Cameras 7 Remote Traffic Monitoring Stations 26 Traffic Signal Controller Upgrades Traffic Signal Coordination 1 Arterial DMS
ITS OPTION 6	Montano	2 Arterial DMS
	Paseo Del Norte	1 Arterial DMS
ITS OPTION 7	Bridge	2 Remote Traffic Monitoring Stations 10 Traffic Signal Controller Upgrades Traffic Signal Coordination
ITS OPTION 8	Rio Bravo	1 CCTV Camera 4 Remote Traffic Monitoring Stations 6 Traffic Signal Controller Upgrades Traffic Signal Coordination 2.7 miles of fiber optic cable and conduit to complete fiber from Coors Boulevard to I-25 (2 segments)
ITS OPTION 9	Louisiana	1 Remote Traffic Monitoring Stations
	Wyoming	1 CCTV Camera
ITS OPTION 10	Unser	5 CCTV Cameras Traffic Signal Coordination 5 Remote Traffic Monitoring Stations 9 TS Controllers Upgrade 1 Arterial DMS
ITS OPTION 11	US 550	1 Remote Traffic Monitoring Stations
ITS OPTION 12	Tramway	6 Remote Traffic Monitoring Stations
ITS OPTION 13	Urban Interstate	54 Ramp Meters
ITS OPTION 14	Extended Area Interstate	1 CCTV Camera 7 Freeway DMS

4. PRELIMINARY OPINIONS OF COST

In order to assist the project team in organizing projects into a two-stage deployment and to provide MRCOG with an understanding of the order of magnitude of the ITS program that has been recommended for deployment to assist in solving some of the Albuquerque area's surface transportation issues, preliminary opinions of cost were developed for each corridor-based project.

While preliminary opinions of cost are provided for planning purposes for each package, conceptual design of each corridor will provide a sound basis for refining these cost estimates. Conceptual and preliminary design of the system-wide projects (including traveler information system, communication network, and the joint operations center) will provide a basis for developing cost estimates for these projects.

Quantities of each ITS element were estimated in order to provide preliminary opinions of cost for each corridor (by phase). Additionally, several corridors were identified by the ITS Subcommittee as candidates for installation of a fiber optic trunk line to support some of the ITS corridor projects and other transportation communication needs of the region. On those corridors, opinions of cost include estimates for purchase and installation of conduit and fiber optic cable. Details of the components and quantities of elements and fiber optic cable for each project were listed in the previous section. Though costs for each corridor were estimated in order to better summarize program funding requirements, in order to more accurately determine the required communications and associated costs, a communication master plan should be developed. The communications master plan should identify the most cost effective means of communicating with each project as recommended by this program.

Table 4-1 summarizes the costs for each "ITS Option". Individual project cost estimate breakdowns are included in the **Appendix**.

Table 4-1: Preliminary Opinions of Cost for Stage 1 Deployment

ITS Option	Corridor(s)	Preliminary Opinion of Cost
ITS OPTION 1	Coors/Alameda/528	\$2,623,500
ITS OPTION 2	2nd Street	\$1,009,800
ITS OPTION 3	Gibson/Central/Louisiana/Lomas	\$462,000
ITS OPTION 4	Montano	\$148,500
ITS OPTION 5	Paseo Del Norte	\$2,103,750
ITS OPTION 6	Bridge/Rio Bravo	\$33,000
ITS OPTION 7	US 550	\$90,750
ITS OPTION 8	Tramway	\$ 763,950
ITS OPTION 9	Urban Interstates	\$7,867,600
ITS OPTION 10	Extended Area Interstates	\$198,000
Stage 1 Total		\$ 15,300,850

Table 4-2: Preliminary Opinions of Cost for Stage 2 Deployment

ITS Option	Corridor(s)	Preliminary Opinion of Cost
ITS OPTION 1	Coors	\$993,300
ITS OPTION 2	Alameda/528	\$660,000
ITS OPTION 3	Gibson Boulevard	\$478,500
ITS OPTION 4	Central	\$1,732,500
ITS OPTION 5	Lomas	\$983,400
ITS OPTION 6	Montano/Paseo Del Norte	\$247,500
ITS OPTION 7	Bridge	\$297,000
ITS OPTION 8	Rio Bravo	\$853,050
ITS OPTION 9	Louisiana/Wyoming	\$66,000
ITS OPTION 10	Unser	\$650,100
ITS OPTION 11	US 550	\$16,500
ITS OPTION 12	Tramway	\$99,000
ITS OPTION 13	Urban Interstate	\$8,910,000
ITS OPTION 14	Extended Area Interstate	\$1,072,500
Stage 2 Total		\$17,059,400

5. BENEFIT/COST ANALYSIS

A benefit/cost analysis was conducted for the corridor-based ITS projects recommended for deployment in the Albuquerque Metropolitan area in order to estimate the benefits that can be expected from deployment of ITS on Albuquerque area roadways. The analysis is meant to provide a basis for the deployment of these projects by estimating actual benefits that the transportation system can experience from each implementation. Benefits such as improved travel times and reduced emissions have been experienced in similar ITS programs in other areas of the Country, as documented by before and after studies. These benefits, compiled into the FHWA-developed IDAS model, form the basis of this benefit/cost analysis. The IDAS model provides a tool to apply actual measured benefits to this particular transportation network utilizing MRCOG's travel demand model. Modeled benefits can assist decision-makers in deploying those projects that have the potential to wield the greatest benefits early in the program.

The benefit/cost analysis was performed for each of the Implementation Corridors described in Section 3. Each of the ITS Options were applied to the network, and the results analyzed. Within IDAS the application of ITS systems, such as an incident management system, generate benefits and not the deployment of individual field equipment, such as CCTV cameras. For example, deployment of CCTV cameras will not produce any benefits within IDAS, but the use of the cameras as part of an Incident Management System, *will* produce benefits. In order to properly input ITS elements into the IDAS model, one must understand what the ITS equipment is intended to do as a component of a type of system. **Table 5-1** lists the Implementation Corridors and the ITS equipment recommended for deployment on the corridors.

Each ITS Option was input into the IDAS model, with Stage 1 options on the 2005 network and Stage 2 options on the 2010 network. A separate model run was performed for each ITS Option and the results tabulated. After each of the ITS Options were run individually, all of the ITS Options were used for a single model run. This resulted in the benefits associated with "All ITS Options Combined." Finally, all of the ITS elements from Stage 1 were imported into the 2010 Network to demonstrate the accrual of additional benefits over time (e.g., between 2005 and 2010 Network volumes).

The IDAS model measures the impact of ITS deployment on the entire system, and not just the specific corridor where the ITS equipment is located. Additionally, in some cases, improvements due to an ITS project on a single corridor may attract more traffic to that corridor, resulting in reduced overall system benefits. Alternately, disbenefits may also be experienced by the system due to a particular project. If additional travelers are utilizing a particular corridor to access Interstate 40, for example, travel times could reduce on I-40 as traffic volumes increase unless ITS elements are also deployed on I-40; therefore, when making ITS investment decisions, overall system performance should be examined.

The results of the IDAS benefit/cost analysis for Stage 1 ITS deployments are shown in **Table 5-1**. The results for Stage 2 Deployment are shown in **Table 5-2**.

Table 5-1: Summary of Deployment Elements for Stage 1 “ITS Options”

ITS Option Packaging in IDAS	Corridors	Total Annual Costs ¹	Total Annual Benefits	Net Benefit (Annual Benefit – Annual Cost)	Annual B/C Ratio
ITS OPTION 1	Coors	\$216,497	\$1,580,923	\$1,364,426	7.30
	Alameda/528				
ITS OPTION 2	2nd Street	\$134,502	\$330,942	\$196,440	2.46
ITS OPTION 3	Gibson Boulevard	\$82,686	\$286,765	\$204,079	3.47
	Central				
	Louisiana				
	Lomas				
ITS OPTION 4	Montano	\$24,867	\$690,372	\$665,505	27.76
ITS OPTION 5	Paseo Del Norte	\$11,996	\$5,667	(\$6,329)	0.47
ITS OPTION 6	Bridge	\$6,899	\$607	(\$6,292)	0.09
	Rio Bravo				
ITS OPTION 7	US 550	\$17,943	\$61,910	\$43,967	3.45
ITS OPTION 8	Tramway	\$102,773	\$28,180	(\$74,593)	0.27
ITS OPTION 9	Urban Interstates	\$589,296	\$3,623,529	\$3,034,233	6.15
ITS OPTION 10	Extended Area Interstates	\$38,409	\$82,248	\$43,839	2.14
TOTAL (Sum of all Stage 1 Options above)		\$1,225,869	\$6,691,143	\$5,465,274	5.46
Phase 1 All ITS Options Combined		\$1,395,978²	\$19,993,770	\$18,597,792	14.32

¹ On those corridors identified as candidates for installation of fiber optic cable, the opinion of cost for communications was removed from the Total Annual Costs for this analysis (Package Cost Summaries in previous sections and in the appendix include costs for conduit and fiber optic cable).

² Model estimation processes result in slight variations in annual costs as compared with the sum of all options.

Table 5-2: Summary of Deployment Elements for Stage 2 “ITS Options”

ITS Option Packaging in IDAS	Corridors	Total Annual Costs	Total Annual Benefits	Net Benefit (Annual Benefit – Annual Cost)	Annual B/C Ratio
ITS OPTION 1	Coors	\$181,716	\$1,204,465	\$1,022,749	6.63
ITS OPTION 2	Alameda/528	\$119,164	\$1,764,591	\$1,645,427	14.81
ITS OPTION 3	Gibson Boulevard	\$84,900	\$60,347	(\$24,553)	0.71
ITS OPTION 4	Central	\$314,324	\$309,614	(\$4,710)	0.99
ITS OPTION 5	Lomas	\$176,840	\$374,956	\$198,116	2.12
ITS OPTION 6	Montano	\$36,296	\$226,760	\$190,464	6.25
	Paseo Del Norte				
ITS OPTION 7	Bridge	\$54,061	\$512,353	\$458,292	9.48
ITS OPTION 8	Rio Bravo	\$48,304	\$471,422	\$ 423,118	9.76
ITS OPTION 9	Louisiana	\$10,946	\$15,539	\$4,593	1.42
	Wyoming				
ITS OPTION 10	Unser	\$114,907	\$333,002	\$218,095	2.90
ITS OPTION 11	US 550	\$2,546	\$46,530	\$43,984	18.28
ITS OPTION 12	Tramway	\$15,785	\$84,327	\$68,542	5.34
ITS OPTION 13	Urban Interstate	\$1,417,881	\$11,215,540	\$9,797,659	7.91
ITS OPTION 14	Extended Area Interstate	\$184,516	\$391,183	\$206,667	2.12
TOTAL (Sum of all Stage 2 Options above)		\$2,762,187	\$17,010,269	\$14,248,082	6.16
All ITS Options Combined (Stage 2)		\$2,778,434	\$31,343,389	\$28,564,955	11.28

The analysis results demonstrate that benefit/cost ratios vary widely between corridors in both the Stage 1 and Stage 2 analyses. This is due to a number of factors, such as:

- IDAS models only the PM peak period, so benefits for projects that would serve AM directional flow, for example, may be under estimated;
- IDAS estimates a 10-year life cycle for all equipment; in reality some elements may experience longer life cycles; and
- IDAS estimates benefits based on system deployments, actual benefits for individual corridors or elements may vary widely from these estimates.

These and other factors require a strong reliance on engineering judgment and past experience to analyze the benefit/cost results from IDAS and draw conclusions for plan phasing.

The Stage 1 and Stage 2 analysis results indicate that while the benefits of deploying ITS on an individual corridor are significant, even larger benefits are derived from deploying ITS over the entire region. As seen in **Table 5-1** and **Table 5-2**, the benefit/cost ratio that is derived from summing the benefits and costs from the individual ITS Options are 5.46 for Stage 1, and 6.16 for Stage 2 ITS Deployment; however, when all of the ITS Options are activated, and the ITS elements work together throughout the entire system to more effectively and efficiently manage traffic, the benefit cost ratios are 14.32 for Stage 1 deployment and 11.28 for Stage 2 deployment.

The above observations support the conclusion that the benefits of system-wide ITS deployment are greater than the benefits accrued from isolated ITS deployment. While individual corridor ITS deployment can reduce travel times, reduce accidents, and improve agency efficiencies on a localized basis, it is recognized that where ITS is deployed regionally, the net benefits of the system-wide deployment will be larger than the benefits accrued from any single device deployment.

One additional IDAS model run was performed to analyze the accrued benefits over time of the Stage 1 deployment period. The results of this analysis, as shown in **Table 5-3**, demonstrates that in addition to the regional improvements due to a full, region-wide deployment of Stage 1 in the short term (2005), over time (2010), the benefits will increase as volumes increase in future years.

Table 5-3: Accrued Benefits of Stage 1 in 2010

ITS Option Packaging in IDAS	Corridors	Total Annual Costs	Total Annual Benefits	Net Benefit (Annual Benefit – Annual Cost)	Annual B/C Ratio
Phase 1 All ITS Options Combined in 2005		\$1,395,978	\$19,993,770	\$18,597,792	14.32
Phase 1 All ITS Options Combined in 2010		\$1,395,978	\$23,756,246	\$22,360,268	17.02

6. CONCLUSIONS

From the benefit/cost analysis results, several recommendations are made that will improve traveler mobility and the reliability of the surface transportation system in the Albuquerque region.

6.1 Freeway Management and Ramp Metering

The Albuquerque region should continue to support ITS deployment on the region's freeways. The Albuquerque Freeway Management System, when complete, will serve as the backbone for continued deployment of ITS throughout the region. When equipped with CCTV cameras, dynamic message signs, and vehicle detection stations, transportation professionals will be better equipped with the tools and resources necessary to improve incident response, and travelers will be provided with the information required to make informed choices that will improve the traveling experience. A potential future ITS implementation on the Albuquerque freeways is a ramp metering system. Deployment of ramp meters, along with other essential elements of a freeway management system, may produce annual benefits exceeding seven million dollars. Ramp metering has been shown to be effective in many other metropolitan areas, and may prove beneficial in the Albuquerque region.

A recent study performed for the Minnesota Department of Transportation on ramp metering in the Twin Cities area revealed the impact of shutting down the ramp metering system for a six-week period of time (*Twin Cities Ramp Meter Evaluation: Executive Summary*, prepared for Minnesota Department of Transportation, February 1, 2001). Results indicated that **without ramp meters**, there was a:

- A 9 percent reduction in freeway volume and a 14 percent reduction in peak period throughput;
- A 7 percent reduction in freeway speeds; and
- A 26 percent increase in crashes.

The study also indicated that **with** ramp meters, there was a 22 percent decrease in freeway travel times, which more than offset the ramp delays caused by ramp meters. Following the test, only 20 percent of the public showed continued support for the shutdown of the ramp meter system, and most of the survey respondents felt that traffic conditions worsened without the ramp metering system.

Analysis of the benefits and costs of the ramp metering system showed that when the costs of the entire freeway management system (including dynamic message signs, traveler information, and other components) are factored in, the benefit/cost ratio for ramp metering is 5:1. When ramp meter benefits are compared to only those costs directly associated with ramp metering, the benefit/cost ratio is 15:1. The ITS Subcommittee should continue to explore the feasibility of deploying ramp metering in the Albuquerque region.

6.2 Coors/Alameda Pilot Project

The benefit/cost analysis reveals a large potential for benefits from ITS deployed on arterials. Specifically, the Coors and Alameda corridors receive considerable benefits from ITS deployment, with an IDAS benefit/cost ratio of 7.3. It is recommended that an arterial ITS pilot

project be deployed on the Coors Boulevard/Alameda corridor, and that before and after studies be conducted to confirm the benefits of ITS on this corridor. Specifically, traffic signal system upgrades, vehicle detection devices, CCTV cameras, and dynamic message signs should be deployed on Coors/Alameda as part of the arterial pilot project.

6.3 Phased Deployment of Signal Coordination and Incident Management

Traffic signal improvements can potentially provide a large benefit to travelers in the region. While improvements to individual corridors can be made, and will benefit area travelers, the largest benefits are derived when traffic signal improvements are made over a wider area. The region's current effort to upgrade many of the traffic signals will provide a large benefit to area travelers. Additional funding should be secured to expand the improvements.

The benefit/cost analysis shows that some of the largest benefits are derived from improved incident management. When incident detection, verification, and response times can be decreased by even small amounts of time, large benefits will be seen by travelers and commuters in the Albuquerque region. Intelligent Transportation Systems can play a major role in improving incident management in the Albuquerque region. Data collection in the form of RTMS and pavement sensors can provide a sound basis for incident management and traveler information. Transportation system operators should continue to explore additional ways to cooperate with emergency responders to improve incident management.

The benefit/cost analysis supports the initial phasing of projects into two stages. Where possible, Stage 1 deployments should include traffic signal coordination and data collection devices with spot coverage by CCTV cameras at critical locations.

6.4 Mainstreaming

The region should look for ways to mainstream the implementation of ITS projects into traditional construction projects. For example, when a roadway is scheduled for widening, conduit for future communications should be installed, thus reducing the overall ITS implementation costs. A current example is the planned reconstruction of the Coors/I-40 interchange. Communications conduit should be installed within the interchange to accommodate future communications needs.

The Albuquerque region should continue to support the implementation of ITS. Though it may be cost-prohibitive to deploy ITS on a large scale within a short period of time, benefits will be derived from a long-term, step-by-step implementation.



APPENDIX A: DESCRIPTION OF IDAS MODEL

The following description of the IDAS model was abstracted from the IDAS software developers' website, <http://camsys.idas.com>.

IDAS is an ITS sketch-planning analysis tool that can be used to estimate the impacts, benefits and costs resulting from the deployment of ITS components. IDAS operates as a post-processor to travel demand models, used by Metropolitan Planning Organizations (MPO), by local agencies, and by State Departments of Transportation (DOT) for transportation planning purposes. IDAS, although a sketch-planning tool, implements the modal split and traffic assignment steps associated with a traditional planning model. These steps are key to estimating the changes in modal, route, and temporal decisions of travelers resulting from ITS technologies. Because IDAS is a sketch planning analysis system, it is intended for use as an alternatives analysis tool and not for ITS operations optimization.

The set of impacts evaluated by IDAS include changes in user mobility, travel time/speed, travel time reliability (non-recurring congestion duration), fuel costs, operating costs, accident costs, emissions, and noise. The performance of selected ITS options can be viewed by market sector (mode), facility type, and district. IDAS produces outputs of the results in a benefit/cost summary report and performance summary reports. Given the diverse types of performance measures that may be impacted by ITS, and the requirements to provide a comprehensive analysis tool, IDAS is comprised of five different analysis modules:

- An Input/Output Interface Module (I/O);
- An Alternatives Generator Module (AGM);
- A Benefits Module;
- A Cost Module; and
- An Alternatives Comparison Module (ACM).

The Benefits Module is further comprised of four submodules: Travel Time/Throughput, Environment, Safety, and Travel Time Reliability. Within each of these submodules, both traditional benefits of ITS deployment (e.g., improvement in average travel time) and non-traditional benefits (e.g., reduction in travel time variability) are estimated. [See IDAS Model Structure – The circled numbers refer to specific chapters of the IDAS User's Manual available under the Documentation heading].

The IDAS Cost Module estimates the life-cycle expenditures by year and the average annual costs for ITS improvements. The cost estimates include public sector capital costs, public sector operating and maintenance costs, private sector capital costs, and private sector operating and maintenance costs. The Cost Module compiles costs based upon the inventory of ITS equipment associated with the ITS components deployed by the user. These costs were obtained from the National ITS Architecture and updated information, and are modifiable by the user.

IDAS is capable of analyzing over 60 different types of ITS investments. These ITS components may be deployed individually or in combination with one another. These components are categorized into 11 areas based on the National ITS Architecture, as depicted in **Table A-1**.

Table A-1: IDAS ITS Components

<p>Arterial Traffic Management Systems</p> <ul style="list-style-type: none"> • Isolated Traffic Actuated Signals • Preset Corridor Signal Coordination • Actuated Corridor Signal Coordination • Central Control Signal Coordination • Emergency Vehicle Signal Priority • Transit Vehicle Signal Priority
<p>Freeway Management Systems</p> <ul style="list-style-type: none"> • Pre-set Ramp Metering • Traffic Actuated Ramp Metering • Centrally Controlled Ramp Metering Advanced Public Transit Systems • Fixed Route Transit – Automated Scheduling Systems • Fixed Route Transit – Automatic Vehicle Location • Fixed Route Transit – Combination Automated Scheduling System and Automatic Vehicle Location • Fixed Route Transit – Security Systems • Paratransit – Automated Scheduling Systems • Paratransit – Automatic Vehicle Location • Paratransit – Automated Scheduling System and Automatic Vehicle Location
<p>Advanced Public Transit Systems</p> <ul style="list-style-type: none"> • Fixed Route Transit • Automated Scheduling System • Fixed Route Transit – Automatic Vehicle Location • Fixed Route Transit – Combination Automated Scheduling System and Automatic Vehicle Location • Fixed Route Transit – Security Systems • Paratransit – Automated Scheduling System • Paratransit – Automatic Vehicle Location • Paratransit – Automated Scheduling System and Automatic Vehicle Location
<p>Incident Management Systems</p> <ul style="list-style-type: none"> • Incident Detection/Verification • Incident Response/Management • Incident Detection/Verification/Response/Management combined

Table A-1: IDAS ITS Components (continued)

Electronic Payment Systems

- Electronic Transit Fare Payment
- Basic Electronic Toll Collection

Railroad Grade Crossing Monitors

Emergency Management Services

- Emergency Vehicle Control Service
- Emergency Vehicle AVL
- In-Vehicle Mayday System

Regional Multimodal Traveler Information Systems

- Highway Advisory Radio
- Freeway Dynamic Message Sign
- Transit Dynamic Message Sign
- Telephone-Based Traveler Information System
- Web/Internet-Based Traveler Information System
- Kiosk with Multimodal Traveler Information
- Kiosk with Transit-only Traveler Information
- Handheld Personal Device – Traveler Information Only
- Handheld Personal Device – Traveler Information with Route Guidance
- In-Vehicle – Traveler Information Only
- In-Vehicle – Traveler Information with Route Guidance

Commercial Vehicle Operations

- Electronic Screening
- Weigh-in-Motion
- Electronic Clearance – Credentials
- Electronic Clearance – Safety Inspection
- Electronic Screening/Clearance combined
- Safety Information Exchange
- On-board Safety Monitoring
- Electronic Roadside Safety Inspection
- Hazardous Materials Incident Response

Table A-1: IDAS ITS Components (continued)

Advanced Vehicle Control and Safety Systems

- Motorist Warning – Ramp Rollover
- Motorist Warning – Downhill Speed
- Longitudinal Collision Avoidance
- Lateral Collision Avoidance
- Intersection Collision Avoidance
- Vision Enhancement for Crashes
- Safety Readiness

Supporting Deployments

- Traffic Management Center
- Transit Management Center
- Emergency Management Center
- Traffic Surveillance – CCTV
- Traffic Surveillance – Loop Detector System
- Traffic Surveillance – Probe System
- Basic Vehicle Communication
- Roadway Loop Detector
- Information Service Provider Center

Generic Deployments

- Link-based
- Zone-based



APPENDIX B: SUMMARY OF IDAS ELEMENTS AND BENEFITS

The following description of the IDAS model was abstracted from the IDAS software developers' website, <http://camsys.idas.com>.

The objective of the IDAS benefits module is to estimate impacts resulting from the deployment of ITS components. These impacts are quantified using various performance measures of travel time, travel time reliability, throughput, safety, emissions, energy consumption and noise. The benefits module uses the updated data set representing the ITS option and the unmodified data set representing the control alternative, to perform a series of analyses to generate the difference in performance between the two scenarios.

The performance statistics are then passed on to the alternatives comparison module where values are attached to the changes in the various measures. The IDAS benefits module is comprised of four individual submodules that provide estimates of impacts for different categories of performance measures. The benefits module consists of a travel time/throughput submodule, an environment submodule, a safety submodule, and a travel time reliability submodule. A brief overview of each of these submodules is provided below, followed by the design specifications for each submodule.

B1.1 Travel Time/Throughput Submodule

The travel time/throughput submodule determines the impacts in transportation system capacity and operational efficiency resulting from the deployment of ITS improvements. Travel time and throughput for vehicles and persons are primary considerations used in the analysis of ITS impacts, and the IDAS model provides a robust analytical procedure to determine ITS benefits as a post-processor to existing regional travel demand models. The travel time/throughput submodule is capable of determining the impacts on traveler responses including route diversion, mode shift, temporal diversion, and induced/foregone demand. The travel time/throughput submodule provides for the examination of these traveler responses by utilizing its own individual submodules to determine shifts of travel related to route choice (trip assignment), mode choice, temporal choice (time-of day), and induced/foregone demand.

B1.2 Environment Submodule

The environment submodule provides a flexible method for estimating changes in mobile source emissions, energy consumption, and noise impacts of ITS strategies. Using the performance statistics generated from the travel time/throughput submodule, the environment submodule estimates environmental performance measures by using a series of detailed look-up tables that consider emissions and energy consumption rates by specific network volume and traffic operating characteristics. The use of look-up tables provides the analyst with the ability to incorporate updated emissions and energy consumption rates as they become available. IDAS incorporates emissions and energy consumption rates from currently available sources, including Mobile 5 and California Air Resources Board EMFAC.

B1.3 Safety Submodule

The IDAS safety submodule provides estimates of changes in the number and severity of accidents resulting from the implementation of ITS strategies. Based on performance statistics calculated from the travel time/throughput submodule, the safety submodule determines the safety benefits by using detailed accident rates using a series of look-up tables. Like the

environment submodule, the safety submodule is flexible to allow use of updated accident rates as they become available.

B1.4 Travel Time Reliability Submodule

Delay experienced by the vehicle traveler can be attributed to two primary sources; recurrent delay caused by congestion on the roadway due to over-saturated conditions, and non-recurrent delay related to incidents, such as crashes and vehicle breakdowns. Recurrent delay is calculated directly from the results of the IDAS trip assignment, mode choice, temporal choice and induced/foregone demand modules. It is the non-recurrent congestion due to incidents that provides the measure of travel time reliability in IDAS.

Improvements to the reliability of travel time are estimated in IDAS by a post-processor immediately following the completion of the final assignment. Separate estimates of travel time reliability are produced for the control alternative and ITS option. ITS components, specified by the user in the alternatives generator, that have the capability of reducing the number of incidents, such as ramp metering, or the duration of incidents, such as incident detection/verification, will result in an improved travel time reliability reported for the ITS option.



APPENDIX C: IDAS BENEFIT/COST RESULTS (COMPLETE TABLE)

Benefit/Cost Summary
ITS Implementation Stage 1
Benefits are reported in 2003
dollars

	1 - Alameda- 528/Coors	2 - 2nd Street Deployment	3 - Gibson/ Central/ Louisiana/ Lomas	4 - Montano	5 - Paseo Del Norte	6 - Bridge/Rio Bravo	7 - US 550	8 - Tramway	9 - Urban Interstates	10 - Extended Area Interstates	Summation of Benefits and Costs	All ITS Options Combined	Stage 1 (2005 Options) on 2010 Network
	8 CCTV 2 Pavement Sensor 10 RTMS 15 Trailblazer Signs TS Signal Coordination	4 CCTV 6 RTMS 17 TS Controller Upgrade Traffic Signal Coordination	9 CCTV 1 Pavement Sensor	1 CCTV 1 Pavement Sensor 5 RTMS	1 Roadbed Sensor 3 RTMS	2 Pavement Sensor	1 CCTV 1 RWIS	1 CCTV 1 RWIS 5 Pavement Sensor 16 T.S. Controller Upgrades	FMS (CCTV, VMS, RTMS), Frontage Road Controller Upgrades and Signal Coordination	2 CCTV 2 RWIS 1 RTMS		All ITS Field Elements from Options 1-10 Deployed on network	All ITS Field Elements from Options 1-10 Deployed on 2010 network
Annual Benefits													
Change in User Mobility	\$ 726,152	\$94,978	(0)	628,398	(0)	(0)	33,230	19,354	1,464,876	82,248	3,049,237	16,461,707	19,672,626
Change In User Travel Time											0		
In-Vehicle Travel Time	\$ 0	0	(0)	0	(0)	(0)	0	0	0	0	0	0	0
Out-of-Vehicle Travel Time	\$ 0	0	(0)	0	(0)	(0)	0	0	0	0	0	0	0
Travel Time Reliability	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	0	172	(0)	172	(0)	196
Change in Costs Paid by Users											0		
Fuel Costs	\$ 485,625	119,910	184,130	38,795	(0)	(0)	18,256	4,472	954,674	(0)	1,805,861	1,783,665	1,996,616
Non-fuel Operating Costs	\$ 899	(1,154)	(0)	(0)	(0)	(0)	(0)	(53)	(4,351)	(0)	(4,660)	601	(1,553)
Accident Costs (Internal Only)	\$ 109,699	50,824	17,085	4,264	4,817	516	2,032	1,869	199,829	(0)	390,934	324,790	399,426
Change in External Costs											0		
Accident Costs (External Only)	\$ 19,358	8,969	3,015	752	850	91	359	330	35,264	(0)	68,988	57,316	70,487
Emissions											0		
HC/ROG	\$ 13,817	3,231	5,346	1,170	(0)	(0)	511	124	37,957	(0)	62,155	62,138	70,622
NOx	\$ 60,512	14,005	21,090	4,304	(0)	(0)	2,243	609	209,898	(0)	312,661	309,583	348,105
CO	\$ 164,453	40,449	56,100	12,689	(0)	(0)	5,279	1,459	725,538	(0)	1,005,968	993,451	1,200,059
PM10	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
CO2	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Global Warming	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Noise	\$ 408	(270)	(0)	(0)	(0)	(0)	(0)	17	(328)	(0)	(173)	518	(338)
Other Mileage-Based External Costs	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Other Trip-Based External Costs	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Change in Public Agencies Costs (Efficiency Improvement)	\$ 0	0	0	0	0	0	0	0	0	0	0	0	0
Other Calculated Benefits	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
User Defined Additional Benefits	\$ 0	0	0	0	0	0	0	0	0	0	0	0	0
Total Annual Benefits	\$ 1,580,923	330,942	286,765	690,372	5,667	607	61,910	28,180	3,623,529	82,248	6,691,143	19,993,770	23,756,246
Annual Costs													
Average Annual Private Sector Cost	\$ 0	0	0	0	0	0	0	0	0	0	0	0	0
Average Annual Public Sector Cost	\$ 216,497	134,502	82,686	24,867	11,996	6,899	17,943	102,773	589,296	38,409	1,225,869	1,395,978	1,395,978
Total Annual Cost	\$ 216,497	134,502	82,686	24,867	11,996	6,899	17,943	102,773	589,296	38,409	1,225,869	1,395,978	1,395,978
Benefit/Cost Comparison													
Net Benefit (Benefit - Cost)	\$ 1,364,426	196,440	204,079	665,505	(6,329)	(6,292)	43,966	(74,593)	3,034,233	43,839	5,465,274	18,597,792	22,360,268
B/C Ratio (Benefit/Cost)	7.30	2.46	3.47	27.76	0.47	0.09	3.45	0.27	6.15	2.14	5.46	14.32	17.02

Benefit/Cost Summary																
ITS Implementation Stage 2																
Benefits are reported in 2003 dollars																
	1 - Coors	2 - Alameda/528	3 - Gibson Blvd	4 - Central Ave.	5 - Lomas	6 - Montano/ Paseo Del Norte	7 - Bridge	8 - Rio Bravo	9 - Louisiana/ Wyoming	10 - Unser	11 - US 550	12 - Tramway	13 - Urban Interstate	14 - Extended Area Interstate	Sum of Costs and Benefits from Stage 2	All Options Combined
	27 TS Controllers TS Coord. 3 Arterial DMS 3 Trailblazer Signs	3 CCTV Cameras 2 RTMS 15 TS Controllers TS Coord. 2 Arterial DMS	3 RTMS 10 TS Cont. TS Coord. 2 Arterial DMS	5 CCTV 10 RTMS 50 TS Controllers TS Coordination	2 CCTV Cameras 7 RTMS 26 TS Controllers TS Coord. 1 Arterial DMS	3 Arterial DMS	2 RTMS 10 TS Controller Upgrade TS Coord.	1 CCTV Camera 4 RTMS 6 TS Controller TS Coord.	1 RTMS 1 CCTV Camera	5 CCTV Cameras 5 RTMS 9 TS Controllers TS Coord. 1 Arterial DMS	US 550 1 RTMS	6 RTMS	54 Ramp Meters	1 CCTV Camera 7 Freeway DMS		All ITS Field Elements from Options 1-10 Deployed on network
Annual Benefits																
Change in User Mobility	\$ 1,160,902	1,428,006	51,165	80,760	107,830	226,760	342,245	414,088	(0)	37,112	(0)	(0)	(43,053)	208,950	4,014,769	23,507,317
Change In User Travel Time															0	
In-Vehicle Travel Time	\$ 0	0	0	0	0	0	0	0	(0)	0	(0)	(0)	0	0	2	0
Out-of-Vehicle Travel Time	\$ 0	0	0	0	0	0	0	0	(0)	0	(0)	(0)	0	0	3	0
Travel Time Reliability	\$ (55)	17	(114)	219	11,287	(0)	4,108	2,855	(0)	46	(0)	(0)	42,556	816	61,739	490
Change in Costs Paid by Users															0	
Fuel Costs	\$ 6,164	139,289	(1,112)	125,600	105,878	(0)	55,441	5,809	9,903	149,440	31,897	53,181	2,156,172	91,290	2,928,960	749,864
Non-fuel Operating Costs	\$ 191	13,793	(3,005)	697	(2,069)	(0)	(69)	(1,995)	(0)	(1,090)	(0)	(0)	3,926	(0)	10,386	28,085
Accident Costs (Internal Only)	\$ 26,194	82,439	4,888	22,583	69,506	(0)	48,423	31,313	906	53,097	(0)	4,886	5,722,886	10,594	6,077,727	5,571,837
Change in External Costs															0	
Accident Costs (External Only)	\$ 4,622	14,548	863	3,985	12,266	(0)	8,545	5,526	160	9,370	(0)	862	1,009,909	1,870	1,072,553	983,253
Emissions															0	
HC/ROG	\$ 15	4,187	(12)	4,076	3,001	(0)	2,208	102	285	4,365	903	1,476	87,047	2,580	110,252	21,384
NOx	\$ 377	17,739	(63)	15,100	13,796	(0)	6,356	736	1,135	19,766	3,821	7,187	479,071	14,670	579,710	105,392
CO	\$ 6,111	65,511	7,807	56,722	53,648	(0)	45,369	13,048	3,149	60,945	9,910	16,734	1,757,132	60,414	2,156,519	376,770
PM10	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	21	(0)
CO2	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	30	(0)
Global Warming	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	22	(0)
Noise	\$ (56)	(938)	(69)	(129)	(186)	(0)	(273)	(61)	(0)	(49)	(0)	(0)	(105)	(0)	(1,842)	(1,003)
Other Mileage-Based External Costs	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	29	(0)
Other Trip-Based External Costs	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	30	(0)
Other Calculated Benefits	\$ (0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	32	(0)
User Defined Additional Benefits	\$ 0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0
Total Annual Benefits	\$ 1,204,465	1,764,591	60,347	309,614	374,956	226,760	512,353	471,422	15,539	333,002	46,530	84,327	11,215,540	391,183	17,010,629	31,343,389
Annual Costs																
Average Annual Private Sector Cost	\$ 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Average Annual Public Sector Cost	\$ 181,716	119,164	84,900	314,324	176,840	36,296	54,061	48,304	10,946	114,907	2,546	15,785	1,417,881	184,516	2,762,187	2,778,434
Total Annual Cost	\$ 181,716	119,164	84,900	314,324	176,840	36,296	54,061	48,304	10,946	114,907	2,546	15,785	1,417,881	184,516	2,762,187	2,778,434
Benefit/Cost Comparison																
Net Benefit (Benefit - Cost)	\$ 1,022,749	1,645,426	(24,554)	(4,711)	198,116	190,465	458,292	423,118	4,593	218,095	43,984	68,542	9,797,659	206,666	14,248,442	28,564,955
B/C Ratio (Benefit/Cost)	6.63	14.81	0.71	0.99	2.12	6.25	9.48	9.76	1.42	2.90	18.27	5.34	7.91	2.12	6.16	11.28

APPENDIX D: CORRIDOR-BASED ITS PROJECT PRELIMINARY COST ESTIMATES (PER PROJECT)

<INSERT COST TABLES FROM EXCEL FILES:

BC Analysis Stage 1 011504.xls

BC Analysis Stage 2 011504.xls>